

CLAIMS

What is claimed is:

1. A method for determining a defect characteristic of a composite
5 structure, the method comprising:

determining a first distance from a first reference point of the
composite structure to a defect;

determining a second distance from a second reference point of the
composite structure to the defect;

10 using the first and second distances to establish a reference area of
the composite structure; and

considering each defect detected within the reference area and
producing therefrom a defect characteristic representative of the
composite structure.

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2. The method of claim 1, wherein considering each defect comprises
summing all of the defects detected within the reference area to produce a total
defect count for the reference area.

20 3. The method of claim 2, further comprising dividing the total defect
count by the reference area to produce a defect-per-unit area of the reference
area.

25 4. The method of claim 3, further comprising comparing the defect
density-per-unit area to a maximum allowable defect density-per-unit area.

5. The method of claim 1, wherein considering each defect comprises:
determining a width for each defect detected within the
reference area; and

30 summing the widths of the defects within the reference area to
produce a width total for the reference area.

6. The method of claim 5, further comprising dividing the width total by the reference area to determine a cumulative defect width-per-unit area of the reference area.

5 7. The method of claim 6, further comprising comparing the cumulative defect width-per-unit area to a maximum allowable cumulative defect width-per-unit area.

10 8. The method of claim 5, wherein determining a width for each defect within the reference area comprises:

selecting, from a digital image of at least a portion of the composite structure including the reference area, a pixel set for each defect within the reference area representing the width of the corresponding defect;

15 determining a pixel count for each selected pixel set; and
correlating each of the pixel counts with correlation data to determine the corresponding widths of the defects within the reference area.

20 9. The method of claim 1, wherein determining a first distance comprises:

determining a linear velocity of a material placement head unit; and
using the linear velocity to determine the first distance.

25 10. The method of claim 9, wherein using the linear velocity comprises:
determining elapsed time between when a course started and when the defect is detected along the course; and
multiplying the linear velocity by the elapsed time.

30 11. The method of claim 9, wherein using the linear velocity comprises:
determining elapsed time between when a first defect is detected along a course and when a second defect is detected along the course;
and

multiplying the linear velocity by the elapsed time.

12. The method of claim 9, wherein determining a linear velocity comprises:

- 5 determining an angular velocity of a compaction roller of the material placement head unit; and
 multiplying the angular velocity by a circumference of the compaction roller.

10 13. The method of claim 12, wherein determining an angular velocity comprises detecting, counting, and establishing frequency of transitions between contrasting portions of a code ring coupled for common rotation with the compaction roller.

15 14. The method of claim 1, wherein determining a first distance comprises:

- counting revolutions of a compaction roller from course start to detection of the defect; and
 multiplying the counted revolutions by a circumference of the
20 compaction roller.

 15. The method of claim 14, wherein counting revolutions comprises detecting and counting transitions between contrasting portions of a code ring coupled for common rotation with the compaction roller.

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 16. The method of claim 1, wherein determining a second distance comprises:

- summing courses completed to produce a total completed course count; and
30 multiplying a predetermined course width by the total completed course count.

17. The method of claim 16, wherein summing completed courses comprises tracking receipt of signals from a machine load cell indicating whether pressure is being applied to a compaction roller.

5 18. The method of claim 1, wherein determining the second distance comprises:

selecting, from a digital image of at least a portion of the composite structure including the second distance, a pixel set representing the second distance;

10 determining a pixel count for the pixel set; and
correlating the pixel count with correlation data to determine the second distance.

15 19. The method of claim 1, wherein the reference area comprises a region of the composite structure bounded by the first and second distances.

20 20. The method of claim 1, wherein the reference area comprises a region of the composite structure bounded by predetermined linear and lateral distances.

21. The method of claim 1, further comprising implementing a user interface for displaying defect data and for allowing at least one user input.

25 22. The method of claim 1, further comprising:
importing a part model of a composite structure;
overlaying a course grid on the part model; and
displaying to a user the part model and course grid.

30 23. The method of claim 22, further comprising:
repositioning the course grid overlay when a new ply is started; and
displaying to a user the part model and the repositioned course grid overlay.

24. The method of claim 1, further comprising:
illuminating at least a portion of the composite structure
acquiring an image of the illuminated portion of the composite
structure; and
5 analyzing the image to identify defects in the illuminated portion of
the composite structure.

25. A method for determining a defect characteristic of a composite structure, the method comprising:

determining a linear velocity of a material placement head unit along a course being laid;

5 using the linear velocity to determine a linear distance from a first reference point along the course to a defect of the composite structure; and

determining a lateral distance from a second reference point of the composite structure to the defect.

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26. The method of claim 25, wherein determining a linear velocity comprises monitoring revolutions of a compaction roller of the material placement head unit.

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27. The method of claim 25, wherein determining a linear velocity comprises:

determining an angular velocity of a compaction roller of the material placement head unit; and

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multiplying the angular velocity by a circumference of the compaction roller.

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28. The method of claim 27, wherein determining an angular velocity comprises detecting, counting, and establishing frequency of transitions between contrasting portions of a code ring coupled for common rotation with the compaction roller.

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29. The method of claim 25, wherein determining a lateral distance comprises:

summing courses completed to produce a total completed course count; and

multiplying a predetermined course width by the total completed course count.

30. The method of claim 29, wherein summing completed courses comprises tracking receipt of signals from a machine load cell indicating whether pressure is being applied to a compaction roller of the material placement head unit.

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31. The method of claim 25, wherein determining a lateral distance comprises:

selecting, from a digital image of at least a portion of the composite structure including the lateral distance, a pixel set representing the lateral distance;

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determining a pixel count for the pixel set; and

correlating the pixel count with correlation data to determine the lateral distance.

32. A method for determining a defect characteristic of a composite structure, the method comprising:

determining a linear velocity of a material placement head unit along a course being laid by monitoring revolutions of a compaction roller of the material placement head unit;

using the linear velocity to determine a linear distance from a first reference point along the course to a defect of the composite structure;

determining a lateral distance from a second reference point of the composite structure to the defect;

using the linear and lateral distances to establish a reference area; and

summing defects within the reference area to produce a total defect count for the reference area.

33. The method of claim 32, further comprising dividing the total defect count by the reference area to determine a defect density-per-unit area of the reference area.

34. The method of claim 32, wherein monitoring revolutions of a compaction roller comprises detecting, counting, and establishing frequency of transitions between contrasting portions of a code ring coupled for common rotation with the compaction roller.

35. A method for determining a defect characteristic of a composite structure, the method comprising:

determining a linear velocity of a material placement head unit along a course being laid by monitoring revolutions of a compaction roller of the material placement head unit;

using the linear velocity to determine a linear distance from a first reference point along the course to a defect of the composite structure;

determining a lateral distance from a second reference point of the composite structure to the defect;

using the linear and lateral distances to establish a reference area;

determining a width for each defect within the reference area; and

summing the widths of the defects within the reference area to produce a width total.

36. The method of claim 35, further comprising dividing the width total by the reference area to determine a cumulative defect width-per-unit area of the reference area.

37. The method of claim 35, wherein monitoring revolutions of a compaction roller comprises detecting, counting, and establishing frequency of transitions between contrasting portions of a code ring coupled for common rotation with the compaction roller.